

**Claims**

What is claimed is:

1. A QoS scheduler for implementing Quality-of-Service (QoS) scheduling with detecting and anticipating the end of a chain of flows comprising:
  4. a first indicator for indicating a number of flows being chained to a physical entry;
  6. a second indicator for indicating when said first indicator has saturated; said second indicator being set active for a flow whose chaining causes said first indicator to saturate;
  9. during de-chaining of said flows from said physical entry, said second indicator being used to determine when said first indicator becomes accurate to begin decrementing said first indicator for detecting the end of the chain of flows; and after said first indicator is decremented, said first indicator being not saturated for anticipating the end of a chain of flows.
1. A QoS scheduler for implementing Quality-of-Service (QoS) scheduling as recited in claim 1 wherein said first indicator and said second indicator include a predefined number of bits (n-bits).
1. A QoS scheduler for implementing Quality-of-Service (QoS) scheduling as recited in claim 2 wherein said first indicator includes n-1 bits and wherein said second indicator includes 1-bit.
1. A QoS scheduler for implementing Quality-of-Service (QoS) scheduling as recited in claim 2 wherein said flow whose chaining causes said first indicator to saturate equals a chained flow number of  $(2^{n-1} - 1)$ .
1. A QoS scheduler for implementing Quality-of-Service (QoS) scheduling as recited in claim 2 wherein said first indicator and said second indicator include three bits (3-bits).
1. A QoS scheduler for implementing Quality-of-Service (QoS) scheduling as recited in claim 5 wherein said first indicator includes 2-bits and said second indicator includes 1-bit.

1        7. A QoS scheduler for implementing Quality-of-Service (QoS)  
2 scheduling as recited in claim 6 wherein said flow whose chaining causes  
3 said first indicator to saturate equals a chained flow number of ( $2^{n-1} - 1$ ) or  
4 three and wherein second indicator is set active.

1        8. A QoS scheduler for implementing Quality-of-Service (QoS)  
2 scheduling as recited in claim 1 wherein said second indicator being active  
3 during de-chaining of said flows from said physical entry for said chained  
4 flow number of ( $2^{n-1} - 1$ ) or three, indicates said first indicator becomes  
5 accurate to begin decrementing said first indicator for detecting the end of  
6 the chain of flows; and said first indicator being not saturated for anticipating  
7 the end of a chain of flows.

1        9. A QoS scheduler for implementing Quality-of-Service (QoS)  
2 scheduling as recited in claim 1 wherein said first indicator is stored in said  
3 physical queue entry.

1        10. A QoS scheduler for implementing Quality-of-Service (QoS)  
2 scheduling as recited in claim 1 wherein said second indicator is stored in a  
3 chain linked list of the chain of flows.

1        11. A scheduling method for implementing Quality-of-Service  
2 (QoS) scheduling with detecting and anticipating the end of a chain of flows  
3 comprising the step of:

4              during chaining of flows to a physical entry; providing a first indicator  
5 for indicating a number of flows being chained to a physical entry;

6              providing a second indicator for indicating when said first indicator has  
7 saturated; setting said second indicator active for a flow whose chaining  
8 causes said first indicator to saturate;

9              during de-chaining of flows from said physical entry, responsive to  
10 identifying second indicator as being set active, decrementing said first  
11 indicator; responsive to decrementing said first indicator, identifying said first  
12 indicator as not saturated for anticipating the end of a chain of flows; and  
13 said first indicator being decremented for detecting the end of the chain of  
14 flows.

1           12. A scheduling method for implementing Quality-of-Service  
2 (QoS) scheduling with detecting and anticipating the end of a chain of flows  
3 as recited in claim 11 wherein the steps of providing said first indicator and  
4 providing said second indicator includes the steps of providing a predefined  
5 number of bits (n-bits) for said first indicator and said second indicator;  
6 utilizing n-1 bits for said first indicator and utilizing 1-bit for said second  
7 indicator.

1           13. A scheduling method for implementing Quality-of-Service  
2 (QoS) scheduling with detecting and anticipating the end of a chain of flows  
3 as recited in claim 12 wherein the step of setting said second indicator active  
4 for said flow whose chaining causes said first indicator to saturate includes  
5 the step of setting said second indicator active for a flow number equal to a  
6 maximum value of said first indicator of ( $2^{n-1} - 1$ ).

1           14. A scheduling method for implementing Quality-of-Service  
2 (QoS) scheduling with detecting and anticipating the end of a chain of flows  
3 as recited in claim 13 includes the steps of setting said second indicator  
4 inactive for all flow numbers being chained to said physical entry greater  
5 than said maximum value of said first indicator of ( $2^{n-1} - 1$ ).

1           15. A scheduling method for implementing Quality-of-Service  
2 (QoS) scheduling with detecting and anticipating the end of a chain of flows  
3 as recited in claim 11 wherein the steps during de-chaining of flows from  
4 said physical entry, responsive to identifying second indicator as being set  
5 active, decrementing said first indicator; responsive to decrementing said  
6 first indicator, identifying said first indicator as not saturated for anticipating  
7 the end of a chain of flows; and said first indicator being decremented for  
8 detecting the end of the chain of flows includes the steps of checking said  
9 first indicator value for being saturated; responsive to said first indicator  
10 value being saturated, checking said second indicator for being active; and  
11 responsive to said second indicator not being active, maintaining said first  
12 indicator.

1        16. A scheduling method for implementing Quality-of-Service  
2 (QoS) scheduling with detecting and anticipating the end of a chain of flows  
3 as recited in claim 15 wherein the step of identifying said first indicator as not  
4 being saturated for anticipating the end of a chain of flows further includes  
5 the steps, responsive to said first indicator not being saturated, utilizing a  
6 counter value of said first indicator for anticipating the end of a chain of  
7 flows.

1        17. A computer program product for implementing Quality-of-  
2 Service (QoS) scheduling of a plurality of flows with detecting and  
3 anticipating the end of a chain of flows, said computer program product  
4 including a plurality of computer executable instructions stored on a  
5 computer readable medium, wherein said instructions, when executed by  
6 said scheduler, cause said scheduler to perform the steps of:  
7              storing a first indicator in a physical entry for indicating a number of  
8 flows being chained to said physical entry;

9              storing a second indicator in a chain linked list of the chain of flows for  
10 indicating when said first indicator has saturated; setting said second  
11 indicator active for a flow whose chaining causes said first indicator to  
12 saturate;

13              during de-chaining of said flows from said physical entry, using said  
14 second indicator to determine when said first indicator becomes accurate to  
15 begin decrementing said first indicator for detecting the end of the chain of  
16 flows; and after said first indicator is decremented, anticipating the end of the  
17 chain of flows responsive to said first indicator being not saturated.

1        18. A computer program product for implementing Quality-of-  
2 Service (QoS) scheduling of a plurality of flows with detecting and  
3 anticipating the end of a chain of flows as recited in claim 17 wherein the  
4 steps of storing said first indicator and storing said second indicator includes  
5 the steps of storing n-1 bits for said first indicator in said physical entry for  
6 indicating a number of flows being chained to said physical entry and storing  
7 1-bit for said second indicator in said chain linked list of the chain of flows for  
8 indicating when said first indicator has saturated.

1           19. A computer program product for implementing Quality-of-  
2 Service (QoS) scheduling of a plurality of flows with detecting and  
3 anticipating the end of a chain of flows as recited in claim 18 wherein the  
4 step of setting said second indicator active for said flow whose chaining  
5 causes said first indicator to saturate includes the step of setting said second  
6 indicator active for a flow number equal to a maximum value of said first  
7 indicator of ( $2^{n-1} - 1$ ).

1           20. A computer program product for implementing Quality-of-  
2 Service (QoS) scheduling of a plurality of flows with detecting and  
3 anticipating the end of a chain of flows as recited in claim 19 includes the  
4 steps of setting said second indicator inactive for all flow numbers being  
5 chained to said physical entry greater than said maximum value of said first  
6 indicator of ( $2^{n-1} - 1$ ).